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Digital Financial Inclusion and Economic Growth in Pakistan: Aggregate and Sectoral Analysis

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This research explores the effect of digital financial inclusion on the economic growth of Pakistan by utilizing quarterly data for the period 2016q1- 2024q4. Having established a long-run relationship using Johansen Co-Integration, a VECM (Vector Error Correction Model) is estimated for short-run and long-run dynamics. Long-run outcomes reveal that digital financial inclusion variables, such as ATMs, mobile wallets, and Internet banking transactions, have positive and significant effects on the country's economic growth. However, Point of Sales (POS) transactions have a long-run negative effect, which indicates that these transactions have retail and consumption-driven usage rather than output-driven usage. Control variables are also affecting GDP growth significantly in the long run; gross fixed capital formation (a proxy of capital) boosts GDP, while increase in the money supply reduces GDP growth possibly due to inflationary expansion. In the short term, capital has a negative influence on GDP, whereas money supply pays GDP dividends from additional liquidity. Digital financial services, such as ATMs and mobile wallets, show some positive but not statistically significant short-term effects, depicting time lags in the usage. There is a small negative short-run effect of internet banking and POS transactions. Post diagnostics tests suggest that there is no serious problem of serial correlation, heteroscedasticity and non-normality. Sectoral analysis indicates different impacts. Mobile wallets and POS have a favorable long-run effect in agriculture, whereas ATMs and internet banking are adverse. It is capital in industry, ATMs, and internet banking that spur growth and mobile wallets and point of sale that retard it. In services, all tools except POS are growth promotive. Short-run sectoral results suggest convergence to equilibrium with dissimilar short-run effects. The results also indicate that digital financial inclusion can stimulate growth, but sectoral specificities and complementarities seem relevant and should be accompanied by digital literacy and infrastructure upgrades.
Keywords: Digital financial inclusion, economic growth, Pakistan, Vector Error Correction Model (VECM), Internet Banking, mobile wallets, ATM transactions, POS transactions, sectoral analysis .

INTRODUCTION

Financial inclusion is the sustainable and responsible provision of affordable and useful financial services to individuals and enterprises, including transactions, payments, savings, credit, and insurance. With the advancement of digital technology, financial inclusion has now encompassed digital financial services on mobile phones, particularly in more than 80 countries, experiencing substantial development in this area (Group, WB). The expanded availability of these digital services spurs economic development within countries and spreads advantages to surrounding nations (Shen et al., 2021). Digital tools within these systems decrease transaction expenses, streamline financial activities, and broaden financial accessibility, consequently boosting consumer expenditure, investment, and business expansion (Quoc, 2024). Furthermore, increased availability of credit and secure savings accounts via digital channels boost entrepreneurial endeavors, fueling economic growth. Digital financial inclusion is vital in fostering economic growth and stability by integrating underserved populations into the financial system. It empowers individuals and small businesses to access credit, manage savings, and make investments, promoting financial independence. Digital platforms enhance transaction efficiency by reducing costs, increasing transparency, and minimizing the time required for

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financial activities, ultimately improving overall financial efficiency. Access to financial services also helps households and businesses build resilience to economic shocks and uncertainty and provides much-needed financial flexibility to the financial sector. Furthermore, the development of fintech solutions is driving innovation in financial services, making them more accessible, more user-friendly, and more cost-effective. Digital financial inclusion encourages more people to enter the formal economy, stimulating consumption, investment, and job creation, which in turn contribute to GDP growth.

In developing nations like Pakistan, where a critical portion of the population remains unbanked or underbanked, digital financial inclusion can be important in addressing systemic issues such as low financial literacy, poor framework, and financial imbalance, creating opportunities for economic development. In Pakistan, only 21% of adults have bank accounts, which is less than the global average of 69% of adults. There is no notable difference in mobile usage between urban and rural areas, with 94.7% and 83% respectively, but internet connectivity differences (17.4% in urban and 1.3% in rural areas) are notable (Siddiqui, 2014). These figures show that digital finance in rural areas still needs improvement. Digital financial inclusion in Pakistan reveals a clear partition between urban and rural regions due to differences in framework, education, and financial conditions. In urban regions, access to financial services is significantly higher, with widespread accessibility of conventional banks, ATMs, and other digital platforms such as mobile wallets and online banking. Urban areas benefit greatly from strong mobile and internet connectivity, which allows citizens to access Easy Paisa and Jazz Cash for payments, savings, and credit. In contrast, rural areas face challenges due to limited banking infrastructure, inconsistent mobile network coverage, and low internet penetration. These limitations leave many rural inhabitants reliant on informal financial systems, creating a gap in financial inclusion and obstructing their access to modern financial services. Higher education levels and technological innovation create a favorable environment for adopting digital financial solutions in cities. Urban inhabitants are more likely to utilize fintech applications and participate in digital payment environments. In rural regions, there are low literacy levels and social obstruction, lack of understanding and lower confidence in these tools. Rural populations often lack awareness of the benefits of digital financial services, which slows adoption rates and perpetuates financial exclusion. This lack of understanding prevents them from using tools to improve their financial management, access to credit, and their overall economic well-being, thus increasing the gap between urban and rural financial inclusion.

The gender gap is another stark difference. Urban women, while still facing societal limitations, are generally superior in accessing financial services and mobile technology. This empowers them to lock in fundamental financial activities and take advantage of focused programs. In rural regions, social standards excessively limit women's financial independence, with limited access to mobile phones or control over their financial choices. This exclusion limits the potential of digital financial inclusion to enable provincial women (Tariq et al., 2021). Digital finance has become essential for improving financial inclusion, particularly in rural regions, where services such as Jazz Cash and Easy Paisa can significantly impact people's lives.

International institutions' studies report a significant potential financial market in Pakistan. According to McKinsey's study, digital payment can improve the 7% GDP and create 4 million jobs, even though a low financial inclusion rate remains in Pakistan (Payfuture, 2021). Pakistan has focused on tools like ATMs, Internet banking, Point of Sales (POS) transactions, and Raast Person-to-Person transfers, which may contribute to economic growth. The State Bank of Pakistan has introduced a licensing and regulatory framework for digital banks. However, in rural areas, there is less knowledge of digital banking. Branchless banking offers digital financial services through mobile phones, retailers, and agents. It includes mobile wallets where a digital account is linked with a mobile number and over-the-counter transactions that customers perform through branchless banking agent locations without having an account. (Tabetando et al., 2022) found that adoption of mobile money has increased in rural areas of Uganda, which in turn has increased the likelihood of using chemical fertilizers and modern seeds in maize production. (Rahaman & Abdulai, 2022) found that adoption of mobile money technology, inputs use, and farm output in rural areas have increased in Ghana due to more investment in education, more access to mobile technology networks, and credit availability. However, for services-related activities, Internet banking plays a crucial role that ensures accessibility and efficiency of various services provisions. This study empirically examines the impact of digital financial inclusion tools, including ATMs, Internet banking, Point of Sales transactions, and mobile wallet transactions, on the economic growth of Pakistan using quarterly data from 2016 to 2024. The study's findings help to analyze the effectiveness of the role of these digital financial inclusion tools and help to formulate appropriate policies that facilitate the country's economic growth. It also analyzes the impact of these instruments on the sectoral economic growth of the country, providing valuable insights into their contribution and effectiveness across different economic sectors. Sectoral analysis highlights the need for targeted policy measures to increase sectoral output.

Objectives of the study

1. Examine the impact of digital financial Inclusion instruments, including ATM, POS, e-banking, and mobile wallet transactions on Pakistan's economic growth.

2. Analyze the impact of digital financial inclusion instruments on Pakistan's economic growth.

Research Questions

1. What are the impacts of digital financial inclusion instruments, including ATMs, point of sale transactions, mobile wallets and online banking on economic growth in Pakistan?
2. How do digital financial inclusion instruments affect sectoral economic growth in agriculture, industry and services?
3. What are the short-and long-term impacts of digital financial inclusion instruments on aggregate and sectoral economic growth?

Many studies have been done in literature to study various dimensions of digital financial inclusion. The studies found that higher digital financial inclusion services facilitate economic growth by bringing the underserved and excluded population into the financial system. Higher digital financial inclusion services support economic growth by reducing transaction costs and channelizing savings into investment. A review of some studies is given in Table A. In literature, most studies based on time series data have used an annual dataset. This study contributes to the literature by examining the impact of digital financial inclusion tools using a quarterly dataset. The study also analyzes the effects of digital financial inclusion tools on sector-wise growth of Pakistan by considering all three sectors including agriculture, industry, and services.

Table A

Author(s) & Year	Title/Study Focus	Data	Estimation technique	Finding
(Ahmad et al., 2021)	Examine the impact of digital financial inclusion (DFI) and human capital on the provincial economic growth of China.	Panel data	Fixed effect model	• Digital financial inclusion index and human capital positively affect China's regional economic growth. • Control variables, including inflation, government expenditures, and population growth, positively affect economic growth, while trade openness negatively influences China's provincial economic growth.
(Rasheed et al., 2019)	Analyze the role of micro digital financial services in providing SMEs access to finance in Pakistan	Time series data	Descriptive analysis	• Digital financial services offered by various microfinance banks strengthen SMEs' access to finance. • The study focuses on reducing the cost of digital financial services and their portfolio for the development of SMEs, playing a crucial role in the country's economic progress.
(Ozturk & Ullah, 2022)	Investigate the impact of digital financial inclusion on the economic growth and environmental sustainability of 42 OBRI nations.	Panel data from 2007 to 2019.	pooled ordinary least squares (OLS), two-stage least squares (2SLS), and the generalized method of moments (GMM) methods	• Advancement of digital financial inclusion leads to economic growth, but increased CO2 emissions also decline environmental quality. • Therefore, policymakers in OBRI regions need to create policies that enhance digital financial inclusion to promote economic growth and environmental sustainability.

Author(s) & Year	Title/Study Focus	Data	Estimation technique	Finding
(Arif et al., 2024)	Analyze the impact of digital economy on Pakistan's economic growth	Annual time series data of Pakistan from 1995 to 2022	Bound testing technique of co-integration and the Error Correction Model	• The findings show that long-term economic growth benefits from increased internet and fixed broadband adoption, underscoring the need to enhance digital technology access to reduce poverty and promote economic development • Mobile cellular subscriptions positively affect economic growth only in the short run due to less technology diffusion, trade restrictions, low ICT proficiency among internet users, and income inequality.
(Manzoor et al., 2021)	Examine the accessibility and delivery of financial services through digitalization in Pakistan.	Secondary information and stakeholders' interviews		• Digitally integrated financial markets play an important role in developing the financial sector, increasing market competition, improving the performance of middle-aged people, and improving productivity in their day-to-day operations. • Digital technology is not enough to increase financial inclusion. A well-created payments framework, customer security shields, excellent physical infrastructure, and appropriate controls are required to cultivate digital financial services.
(Salman et al., 2024)	Investigate the relationship between using advanced wallets and financial inclusion and economic empowerment in rural Pakistan.	An online survey was conducted with 476 respondents from the rural locality of Pakistan, Dera Ghazi Khan.	Quantitative analysis	• The study found a positive relationship between usage, accessibility, and control of digital wallets and inclusive access to finance and economic development. • Access to digital financial services increases financial access and creates economic opportunities for rural women in Pakistan.
(Hashemizadeh et al., 2023)	Analyze the effects of digital financial inclusion and ICT on economic growth	38 OECD nations between 2004 and 2020	Cointegration technique	• The study finds a positive correlation between digital financial inclusion, ICT, population growth and non-financial investment. • Financial services can be provided to the excluded and unserved population by investing in digital technologies.

***Theoretical framework and empirical model*:** This study followed the classical theory of growth (Solow, 1956) and financial intermediation theory developed by (Levine, 1997) to analyze the impact of digital financial inclusion tools on economic growth. According to classical (Solow, 1956), economic growth depends on physical capital and labour, with total factor productivity (TFP) playing an important role. In mathematical form, the production function can be expressed as:

$$Y = AK^{\alpha}L^{\beta}$$

Y is the total output produced
K is the capital
L is labour
A is the total productivity factor.

In the classical growth model, physical capital and total factor productivity are primary drivers of economic growth in the long run. Labor is assumed to grow exogenously. TFP is dependent on technology, digital financial inclusion, and infrastructure.

According to financial intermediation theory, if financial markets, including digital financial inclusion tools, are well-functioning, they accumulate more capital and increase productivity by channeling funds from savers to investors and decreasing transaction costs. The basic Solow model is

extended by incorporating digital financial inclusion tools in total productivity.

A= F (ATM, Intbanking, mobile wallets, POS, BM)

ATM: Volume of ATM transactions

Intbanking: Volume of internet banking

Mobile wallets: Volume of mobile wallet transactions

POS: Point of Sales transactions

BM: Broad money

$Y = \mathrm{F}(\mathrm{ATM}, \mathrm{Intbanking}, \mathrm{mobile\ wallets}, \mathrm{POS}, \mathrm{BM}) K^{\alpha} L^{\beta} \ \ldots$ (Eq. A)

We have considered labor exogenously determined and have not included it in the model for simplicity.

Taking the log of Eq. A, we get:

$$Log\ Y = \log A + \alpha LogK$$

$$\begin{aligned} Log\ Yt = \alpha_0 &+ \alpha_1 \log(\mathrm{K}_t) + \alpha_2 \log(\mathrm{Broadmoney}_t) \\ &+ \alpha_3 \log(\mathrm{ATM}_t) \\ &+ \alpha_4 \log(\mathrm{mobile_wallets}_{\mathrm{w}_t}) \alpha_5 \log(\mathrm{POS}_t) \\ &+ \alpha_6 \log \mathrm{Int_banking}_t) + \eta_t \end{aligned}$$

Following VECM, the model is estimated to find short-run and long-run coefficients:

$$\begin{aligned} \Delta GDP_t = \alpha * (& GDP_(t-1) + \beta 1 * CAPITAL_(t-1) \\ & + \beta 2 * BROAD_MONEY_(t-1) + \beta 3 \\ & * ATM_(t-1) + \beta 4 \\ & * MOBILE_WALLETS_(t-1) + \beta 5 \\ & * POS_(t-1) + \beta 6 * INT_BANKING_(t \\ & -1) + c) + \gamma 1 * \Delta GDP_(t-1) + \gamma 2 \\ & * \Delta GDP_(t-2) + \gamma 3 * \Delta CAPITAL_(t \\ & -1) + \gamma 4 * \Delta CAPITAL_(t-2) + \gamma 5 \\ & * \Delta BROAD_MONEY_(t-1) + \gamma 6 \\ & * \Delta BROAD_MONEY_(t-2) + \gamma 7 \\ & * \Delta ATM_(t-1) + \gamma 8 * \Delta ATM_(t-2) \\ & + \gamma 9 * \Delta MOBILE_WALLETS_(t-1) \\ & + \gamma 10 * \Delta MOBILE_WALLETS_(t-2) \\ & + \gamma 11 * \Delta POS_(t-1) + \gamma 12 * \Delta POS_(t \\ & -2) + \gamma 13 * \Delta INT_BANKING_(t-1) \\ & + \gamma 14 * \Delta INT_BANKING_(t-2) + \varepsilon_\mathrm{t} \end{aligned}$$

The exact derivation applies to each sector for sectoral analysis, replacing GDP with sectoral output.

***Variables and Data sources*:** The dependent variable in aggregate analysis is GDP, while the independent variables are capital, broad money, ATM transactions, mobile wallet transactions, Point of Sales transactions, and internet banking transactions. For sectoral analysis, the output of the agriculture, industry, and services sectors is the dependent variable. All variables are taken in the log form. Data on GDP, agriculture output, industrial output, service sector output, and fixed capital formation (a proxy for capital) are taken from Quarterly National Accounts, available on the Pakistan Bureau of Statistics website. Data on digital financial inclusion variables, including mobile wallets, ATM transactions, internet banking, and POS transactions, are taken from quarterly reports of the Payment System Review published by the State Bank of Pakistan. Monthly data on broad money is taken from the Statistical Bulletin of the State Bank of Pakistan. Quarterly data is computed from monthly data. Quarterly data from 2016 to 2024 is used for two reasons: availability of data for all variables and significant advancements in digital financial inclusion and their use.

Table 1. Measurement of variables.

Variables	Measurement
ATM transactions	Volume of Automated Teller Machine transactions (no. of transactions)
POS transactions	Volume of Point of Sales transactions (Number of transactions)
Internet banking	Volume of Internet Banking transactions (Number of transactions)
fixed capital formation	Value of Gross Fixed Capital Investment at constant local currency unit
Broad money	Value of Broad Money (M2)
GDP	Value of Gross Domestic Product at constant basic prices of 2015-16
Agriculture output	Value of agricultural output at constant basic prices of 2015-16
Industrial output	Value of industrial output at constant basic prices of 2015-16
Service sector output	Value of services sector output at constant basic prices of 2015-16

RESULTS AND DISCUSSION

Descriptive statistics of variables are computed first to analyze the dataset's properties. Comparing minimum and maximum values with the mean value given in Table 1, we can find that the values are close to the mean, which confirms that there is no problem of outliers in our data. Mean and median values of all variables are very close, showing that the data is not highly skewed or fully symmetrical. Standard deviation values for broad money and ATM transactions are high, showing more fluctuations, while other variables have small standard deviation values, indicating a stable trend over time. P-values of the Jarque-Bera test are greater than 0.05, so we fail to reject the null hypothesis. This means that data for all variables can be considered normally distributed based on the Jarque-Bera test.

Table 2. Descriptive statistics of variables.

Descriptive Statistics of Variables

Variable	Mean	Median	Max	Min	Std_Dev	JB_Statistic	JB_Prob
GDP	12.979430	12.979860	13.026740	12.915240	0.034316	2.136369	0.343632
CAPITAL	12.069290	12.053170	12.261990	11.950690	0.075525	5.600163	0.060805
BROAD_MONEY	13.308550	13.309780	13.554870	13.077720	0.141707	2.197841	0.333231
ATM	8.136788	8.119256	8.373831	7.915405	0.131404	1.172079	0.556527
AGR	12.317360	12.318200	12.392700	12.246560	0.039079	1.375144	0.502795
IND	12.229320	12.237120	12.284770	12.134260	0.031264	7.021533	0.029874
INT_BANKING	7.179566	7.123852	7.767898	6.625724	0.366862	2.948324	0.228970
MOBILE_WALLETS	8.494989	8.563960	9.268391	7.619229	0.459212	2.030744	0.362268
POS	7.337557	7.276462	7.848805	6.918607	0.266401	2.054613	0.357970
SER	12.714440	12.716500	12.768180	12.638390	0.040278	2.217201	0.330020

Most time series variables are non-stationary, so first we checked whether the variables are stationary or non-stationary. Augmented Dicky Fuller (ADF) test is used to check stationarity of data and results are given in Table 2. Results of the ADF test show that all variables are non-stationary at a level and become stationary at first difference. Because the p-value for all variables at the first difference is less than 0.0.5, we reject the null hypothesis that the series has a unit root.

Table 3. Augmented Dicky Fuller test at level and first difference.

ADF Test Results (Level and First Difference)

Variable	t_Statistic_Level	P_Value_Level	t_Statistic_1st_Diff	P_Value_1st_Diff
ATM	-0.1930	0.9301	-6.9034	0.0000
Broad_Money	1.1479	0.9970	-10.4336	0.0000
Capital	-1.9367	0.3119	-3.3303	0.0233
GDP	-1.4881	0.5275	-7.1349	0.0000
Internet_Banking	-0.1125	0.9401	-7.4969	0.0000
Mobile_Wallets_Transactions	-1.1500	0.6842	-4.8184	0.0005
POS	-0.1601	0.9343	-6.4711	0.0000

As all variables are non-stationary at the level and become stationary at first difference, a long-run relationship among them is possible. First, we decide the optimal lag length based on the Vector Auto-regressive model and then apply the Johansen Co-integration test to confirm the long-run relationship. Based on the test results given in Table 3, lag 2 order is selected as suggested by all test criteria.

Table 4. VAR Lag Order Selection Criteria.

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ	Selected
0	746.2804	NA	1.98e-32	-44.62305	-44.16956	-44.47047	
1	1004.1960	343.8875	1.80e-36	-54.19370	-49.20534	-52.51527	
2	**1222.7770**	**158.9678**	**1.05e-38**	**-61.38041**	**-51.85718**	**-58.17613**	*

Notes: * indicates lag order selected by the criterion.
LR: sequential modified LR test statistic (each test at 5% level).
FPE: Final prediction error.
AIC: Akaike information criterion.
SC: Schwarz information criterion.
HQ: Hannan-Quinn information criterion.

Table 4 shows the results of the Johansen Co-integration test. Trace statistics and Maximum eigenvalues confirm two co-integrating equations at a 5% significance level. The test statistics of both Trace and Maximum eigenvalues are greater than the critical values at most order 1, so we reject the null hypothesis, confirming a long-run relationship among variables.

Table 5. Results of the Johansen Cointegration Test.

Johansen Cointegration Test Results

		Trace Test			Max-Eigen Test		
Hypothesized.CEs	Eigenvalue	Trace.Stat	Trace.CV..5..	Trace.Prob	Max.Eigen.Stat	Max.Eigen.CV..5..	Max.Eigen.Prob
None	0.7823	152.7561	125.6154	0.0004	50.3159	46.2314	0.0173
At most 1	0.7136	102.4403	95.7537	0.0160	41.2606	40.0776	0.0366
At most 2	0.4946	61.1797	69.8189	0.2009	22.5166	33.8769	0.5676

Trace test and Max-Eigen value test indicate 2 cointegrating equations at the 0.05 level.

After confirmation of a long-run relationship among variables, the Vector Error Correction model (VECM) is estimated to find both short-run and long-run coefficients. VECM accounts for endogeneity problem that arises because of bi-directional relationship between digital financial inclusion and economic growth. VECM treats endogeneity by treating all variables as endogeneous and allows feedback effects by modeling each variables as a function of its own lag and lags of other variables. Results of VECM long-run and short-run coefficients are given in Tables 5 and 6, respectively. Coefficient value of capital 0.11 which shows that 1 percent increase in gross fixed capital formation (a proxy for capital) increases GDP by 0.114 percent on average in the long run. Investment always remain a key factor that derives long-run economic growth of a country in the literature (Zamilur & Ferdaus, 2021). Higher money supply affects long run economic growth negatively in our results. 1 percent Increase in money supply decreases GDP by 0.47 percent on average in the long run. This is possible in the case of Pakistan, where excessive money supply may generate inflationary pressures which ultimately hurt investment, decrease consumption, and slow economic growth. Various empirical studies also confirm that excessive money supply leads to higher inflation in Pakistan (Stylianou et al., 2024). Digital financial inclusion variables, including ATM transactions, mobile wallet transactions and internet banking transactions, have a long-run positive impact on economic growth. One percent increase in ATM, mobile wallet, and internet banking results in 0.28, 0.045, and 0.13 percent increase in GDP, respectively. Higher digital financial inclusion services facilitate businesses in online transactions, making payments and managing financial resources, ultimately leading to industrial production and sustainable economic growth. However, point-of-sales transactions have an adverse long-run impact on economic growth. It shows that POS transactions are more retail-based and consumption-based than industrial production or investment transactions. All independent variables significantly impact GDP growth as t-values are equal to or greater than 1.85. (Rahman et al., 2024) found that digital financial inclusion tools including Point of Sales transactions and e-commerce transactions have positive impact on GDP growth while ATM transactions affect output negatively in case of Bangladesh. (Mukherjee & Gaur, 2024) studied the role of ATMs in financial inclusion of India. Increased accessibility and use of ATMs built trust

in banking infrastructure, especially encouraging participation of unbanked and underbanked population.

The short-run coefficient of capital in Table 6 is negative, showing that capital investment may not translate into output growth and may reduce liquidity or divert resources from consumption in the short run. An increase in the money supply increases output in the short run by increasing the availability of credit and liquidity in the economy, which may stimulate production and consumption. ATM and mobile wallet transactions have positive but insignificant effects on GDP in the short run. It shows that the immediate effect of digital financial services on GDP is not strong enough because of time lag, limited adoption and usage, particularly in rural areas, infrastructure constraints and more preference for cash-based transactions in some sectors. The effect of POS transactions on GDP is also negative but insignificant in the short run. Internet banking has a negative and insignificant short-run effect on output. In the short run, internet banking involves costs for businesses and consumers. Low digital literacy and cybersecurity concerns cause more inefficiencies and hamper growth, and it takes more time to support economic expansion. R-square is 0.47 which indicates that 47 percent variations in GDP are due to independent variables, considered in this study.

Table 6. VECM-Long-run coefficients.

VECM Long-run Coefficients and t-Statistics

Variable	Coefficient	t_Statistic
GDP(-1)	1.000000	NA
CAPITAL(-1)	0.114121	10.75170
BROAD_MONEY(-1)	-0.477633	-14.46530
ATM(-1)	0.288918	11.06310
MOBILE_WALLETS_TRANSACTI(-1)	0.045564	7.99291
POS(-1)	-0.019110	-1.84803
INT_BANKING(-1)	0.133371	16.41450
C	14.403730	NA

Table 7. VECM-short-run coefficients.

VECM Short-run Coefficients and t-Statistics

Variable	Coefficient	t_Statistic
CointEq1	-0.301764	-0.86080
D(GDP(-1))	-0.005458	-0.01323
D(GDP(-2))	0.254346	0.60519
D(CAPITAL(-1))	-0.034530	-0.59751
D(CAPITAL(-2))	-0.088187	-1.97767
D(BROAD_MONEY(-1))	0.403910	1.24864
D(BROAD_MONEY(-2))	0.946439	2.42950
D(ATM(-1))	0.071581	0.47684
D(ATM(-2))	0.067397	0.43746
D(MOBILE_WALLETS_TRANSACTI(-1))	-0.007087	-0.08471
D(MOBILE_WALLETS_TRANSACTI(-2))	0.069001	0.77808
D(POS(-1))	-0.017630	-0.27115
D(POS(-2))	-0.017759	-0.33038
D(INT_BANKING(-1))	-0.101617	-1.51780
D(INT_BANKING(-2))	-0.097139	-1.55401
C	-0.013428	-1.17716

* R-squared = 0.4774

Residual diagnostic tests are performed to check autocorrelation, heteroscedasticity, and normality. Autocorrelation is checked through a serial correlation LM test, and results are given in Table 7. Probability values at lag 1 and lag 2 are greater than the 5% level of significance, which implies the acceptance of the null hypothesis, showing no serial correlation problem.

Table 8. VEC Residual Serial Correlation LM test.

VEC Residual Serial Correlation LM Test Results

Lag	LM.Statistic	Probability
1	53.37521	0.3098
2	44.62419	0.6510

[a] Null Hypothesis: no serial correlation at lag order h

Heteroscedasticity is checked through the VECM Residual Heteroscedasticity Joint test. The result given in Table 8 shows that residuals are homoscedastic, as the P-value is greater than 00.05. It shows that there is no problem of heteroscedasticity.

Table 9. VEC Residual Heteroscedasticity Joint Test.

VEC Residual Heteroskedasticity Joint Test Result

Chi.Square	Degrees.of.Freedom	Probability
864.7197	840	0.2698

The result of the normality test (Table 9) based on Jarque-Bera confirms that the model is normally distributed. The null

hypothesis is accepted because the p-values of most of the components and the joint P-value are greater than 0.05.

Table 10. VECM Residual Normality Test.

VECM Residual Normality Test Results

Component	Jarque_Bera	df	Prob
1	6.582296	2	0.0372
2	0.041326	2	0.9795
3	6.838201	2	0.0327
4	0.746604	2	0.6885
5	1.109689	2	0.5742
6	2.266370	2	0.3220
7	0.040876	2	0.9798
Joint	**17.625360**	**14**	**0.2244**

For analysis of the impact of digital financial inclusion on sectoral economic growth, the VECM model is estimated for each sector: agriculture, industry, and services, after confirmation of Co-integration using quarterly data from 2016 to 2024. The results of VECM long-run and VECM short-run coefficients for all three sectors are given in Tables 10 and 11, respectively. The effects of digital financial inclusion tools vary across sectors.

In the agriculture sector, ATM transactions are associated with lower output from the agriculture sector in the long run. In rural Pakistan, ATMs are used mainly for consumption withdrawals rather than investment. ATMs are not accessible to all people in rural areas, showing a disconnect between cash access and productive agriculture development. Internet banking also hurts GDP growth in the agriculture sector. This result shows various challenges, like the digital literacy gap in rural communities and the lack of integration of online banking tools with agriculture credit and other financial products. Providing an Internet banking platform without a support system cannot increase agricultural productivity. (Pandey et al., 2010) highlighted that new payment mechanisms in India, such as mobile-based and card-based transactions, increased the convenience and revolutionized the payment system in agriculture value chains. Other digital financial inclusion tools, including POS and mobile wallets, have significant long-run positive effects on GDP growth from agriculture. Mobile wallets allow people to access financial services for payments and transfers, ultimately supporting the agriculture sector. An increase in the money supply provides credit accessibility, supporting more investment in the agriculture sector, which results in more output growth. Capital has a positive and insignificant effect on the agriculture sector's output. This implies that a relatively small share of gross fixed capital formation goes to the agriculture sector, or its contribution is relatively small to the growth of this sector.

Table 11. VECM long run coefficients-sectoral analysis.

VECM Long-Run Coefficients with t-Statistics

Sector	Variable	Coefficient	t_value
Agriculture	ATM	-0.1513	3.6905
Agriculture	BROAD_MONEY	0.3828	-2.9167
Agriculture	CAPITAL	0.0023	0.1694
Agriculture	INT_BANKING	-0.0524	4.8724
Agriculture	MOBILE_WALLETS	0.0151	1.9553
Agriculture	POS	0.0214	3.8543
Agriculture	C	8.2228	NA
Industry	CAPITAL	0.4882	22.9137
Industry	BROAD_MONEY	-0.1522	2.6602
Industry	ATM	0.3317	6.8598
Industry	INT_BANKING	0.1522	10.5141
Industry	MOBILE_WALLETS	-0.0149	-1.4537
Industry	POS	-0.1384	-7.2703
Industry	C	-5.7139	NA
Services	POS	-0.0376	-1.1843
Services	MOBILE_WALLETS	0.0410	2.6888
Services	INT_BANKING	0.1480	7.2963
Services	CAPITAL	0.0197	0.8799
Services	BROAD_MONEY	-0.0397	-5.4920
Services	ATM	0.2539	3.2115
Services	C	14.5635	NA

In the industrial sector, gross fixed capital formation (a proxy for capital) significantly impacts industrial output growth. This implies that capital/investment is a key driver for the development of this sector. An increase in the money supply is associated with negative industrial output growth. Excessive supply generates inflationary pressures that ultimately curtail consumption and investment, leading to lower industrial growth. Digital financial inclusion variables, including ATMs and internet banking, significantly affect industrial sector growth. Access to ATMs helps businesses to manage their transactions and liquidity smoothly. Similarly,

internet banking facilitates business in online transactions, payments, and financial management, contributing to the sector's development. Various empirical studies found positive impact of online transactions on economic growth in developing countries (Kabango & Asa, 2015). Other digital financial services, like mobile wallets and POS transactions, negatively affect industrial sector output. The effect of mobile wallets is insignificant; this could be because generally small transactions are carried out through mobile wallets, and the industrial sector depends on large-scale transactions, payments, and banking systems. POS transactions are more consumption-based rather than investment or production activities.

In the services sector, all digital financial inclusion tools except POS transaction support facilitate service sector growth in the long run. Easy access to ATMs, particularly in urban areas, leads to more consumption and spending on services. Internet banking has also made it easy to manage and process payments, payroll, and client transactions. Mobile wallets also help customers make payments digitally, boosting aggregate demand. POS transactions have a negative and insignificant effect on the services sector growth, showing low usage of POS in the services sector. Gross fixed capital formation/capital has a positive but insignificant effect on the growth of the services sector. Gross fixed capital formation is the investment in fixed assets like buildings, machinery, etc., which is not only sufficient to increase output from services; human capital and technology play a more important role in the services sector growth. This result also indicates a misallocation of resources or underinvestment in productive capital. An increase in the money supply has hurt the growth of the services sector mainly due to inflationary pressures, higher input costs, and low purchasing power.

Short-run coefficients of VECM for each sector are given in Table 11. The coefficients of the co-integrating equation are negative and significant for each sector, showing convergence to equilibrium. Mobile wallets negatively affect the agriculture sector's output growth in the short run. This is mainly due to low adoption in rural areas, poor digital infrastructure, lack of trust in digital systems, preference for cash-based transactions, and absence of policy support and awareness. Money supply has an adverse short-run effect on agricultural output, while a capital increase contributes to more agricultural sector output even in the short run. Internet banking positively affects the agricultural sector's output in the short run. Internet banking has made it convenient for farmers to get loans, make payments and transfers, and get price updates, contributing to higher output growth in this sector.

Table 12. VECM short-run coefficients-sectoral analysis.

Sector	Variable	Coef.	t-value
Agriculture			
Agriculture	CointEq1	-1.5400	-8.7146
Agriculture	D (AGR (-1))	0.5340	5.5313
Agriculture	D (ATM (-1))	0.1892	3.1035
Agriculture	D (BROAD_MONEY (-1))	-0.2057	-1.6762
Agriculture	D (CAPITAL (-1))	0.0467	3.2667
Agriculture	D (INT_BANKING (-1))	0.0508	2.1481
Agriculture	D (MOBILE_WALLETS (-1))	-0.0941	-3.1447
Agriculture	D (POS (-1))	-0.0623	-2.6552
Agriculture	C	0.0065	2.4152
Industry			
Industry	CointEq1	-1.7637	-6.2036
Industry	D (IND (-1))	0.7138	2.8878
Industry	D (IND (-2))	0.3982	2.2978
Industry	D (CAPITAL (-1))	-0.5677	-4.8892
Industry	D (CAPITAL (-2))	-0.3251	-4.5758
Industry	D (BROAD_MONEY (-1))	-0.2997	-0.7350
Industry	D (BROAD_MONEY (-2))	0.7109	1.5187
Industry	D (ATM (-1))	-0.3131	-1.3963
Industry	D (ATM (-2))	0.0629	0.2776
Industry	D (INT_BANKING (-1))	-0.4071	-4.5540
Industry	D (INT_BANKING (-2))	-0.5203	-5.5854
Industry	D (MOBILE_WALLETS (-1))	0.2015	1.8634
Industry	D (MOBILE_WALLETS (-2))	0.3133	2.3295
Industry	D (POS (-1))	0.2149	2.1538
Industry	D (POS (-2))	-0.0484	-0.6089
Industry	C	-0.0015	-0.1126
Services			
Services	CointEq1	-0.6854	-2.3217
Services	D (SER (-1))	0.4226	1.4000
Services	D (POS (-1))	-0.0132	-0.2829
Services	D (MOBILE_WALLETS (-1))	-0.0056	-0.0831
Services	D (INT_BANKING (-1))	-0.0591	-1.0814
Services	D (CAPITAL (-1))	-0.0341	-1.0867
Services	D (BROAD_MONEY (-1))	0.3426	1.0675
Services	D (ATM (-1))	0.0180	0.1406
Services	C	-0.0002	-0.0343

Capital negatively impacts output growth in the industry in the short run. Higher capital investment in industry takes time to return, reducing resources available for agriculture. ATM transactions and mobile wallets positively affect industrial sector output in the short run, while internet banking and POS transactions affect output negatively. Short-run is a transition period to adopting Internet banking for transactions, payments, and financing, so that businesses may face short-run liquidity problems affecting procurement and production cycles. Capital affects the services sector's output negatively in the short run, and the effect is insignificant. Capital is an investment in a long-term project that will not give an immediate return but requires a higher cost. As a result, existing workflows get disrupted due to new investment,

negatively affecting the growth of the services sector. An increase in the money supply has positive effects on the services sector's output. A higher money supply initially increases demand for services. Producers will also increase short-term investment due to credit availability at low interest rates. In the short run, all variables have an insignificant impact on the services sector's output.

***Conclusion*:** The study examines the impact of digital financial inclusion tools on the economic growth of Pakistan using quarterly data from 2016 to 2024. The co-integration test confirms the existence of long-run relationships among variables. The VECM model is estimated to find short-run and long-run coefficients. The results of the VECM indicate that digital financial instruments and services, including ATM use, internet banking, and mobile wallet transactions, are making a significant contribution to long-term economic growth. However, the point of sales hurt growth, showing that these transactions are more retail-based and consumption-based than investment-based. Physical capital is an important variable that drives economic growth in the long run. In the long run, the money supply increase hurts economic growth through inflationary pressures and inefficiencies. The short-run impact of ATM transactions and mobile wallets on GDP growth is positive but insignificant, showing a lag effect due to low adoption of digital technologies, particularly in rural areas, more preference for cash transactions in some sectors, inaccessibility of ATMS in some rural areas, etc. Internet banking has adverse and insignificant short-term effects due to various factors, including lack of trust, low adoption of Internet banking services, security concerns, framework issues, and digital literacy gaps.

Sectoral effects of digital financial inclusion tools are found by estimating VECM for each sector (agriculture, industry, and service), revealing valuable insights for each sector. ATM usage and Internet banking negatively affect agricultural output in the long run. This implies that the agriculture sector faces more challenges in adopting digital financial services, including ATMs and Internet banking, due to digital literacy gaps in rural communities, connectivity issues, and a lack of online banking integration with agriculture credit and other incentives. There is a need to focus on providing necessary support and a platform for Internet banking to increase productivity in this sector. However, in the short run, these tools positively impact agricultural output, but over time, they will not facilitate high output growth due to all the above factors. Mobile wallets have a significant positive effect on output growth in the long run because people in rural areas use these wallets to carry out financial transactions, which support agricultural productivity. Both money supply and capital positively impact on the agriculture sector's output in the long run, indicating that higher availability of credit and investment results in more output in this sector. In the industrial sector, capital is a key driver of industrial output. Digital financial inclusion variables, including ATM transactions and internet banking, are important tools that facilitate higher industrial output growth. Consumers usually use mobile phones to carry out small transactions and do not contribute significantly to the higher output growth of this sector. In the services sector, all digital financial inclusion tools except POS transactions contribute to the growth of this sector in the long run. The above analysis reveals that the effects of digital financial tools vary across sectors; therefore, targeted sector-wise intervention is required to get the benefits of digital financial inclusion in the form of higher output in each sector. Rural areas need to focus on minimizing the digital literacy gap through awareness sessions, improving education in rural areas, improving ICT infrastructure, and linking agriculture sector incentives with online banking. In the industry and services sectors, long-run output can be increased by higher adoption of ATMs, internet banking, and mobile wallets.

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***SDGs addressed*:** Decent Work and Economic Growth, Industry, Innovation, and Infrastructure, Reduced Inequalities

***Policy referred*:** Pakistan's National Financial Inclusion Strategy, State Bank of Pakistan's (SBP) Policies on Digital Banking and Financial Innovation

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